

# Genetic Diversity and Fumonisin Analyses of Fusarium species in the Philippines

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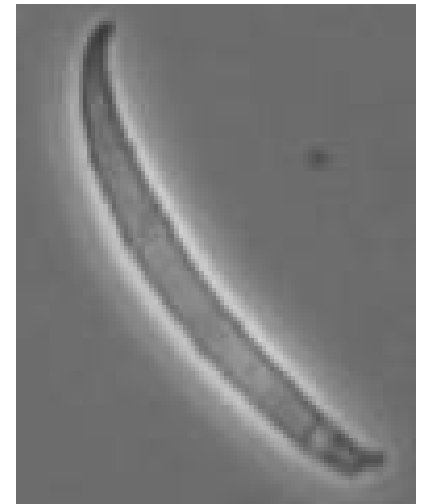
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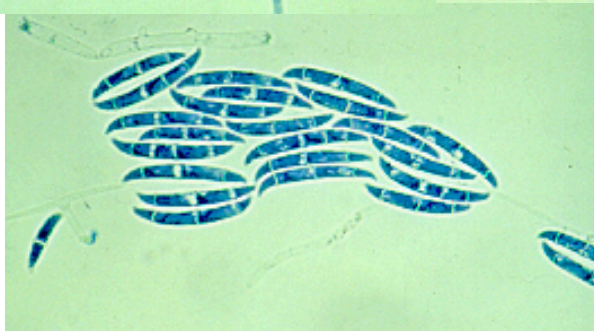
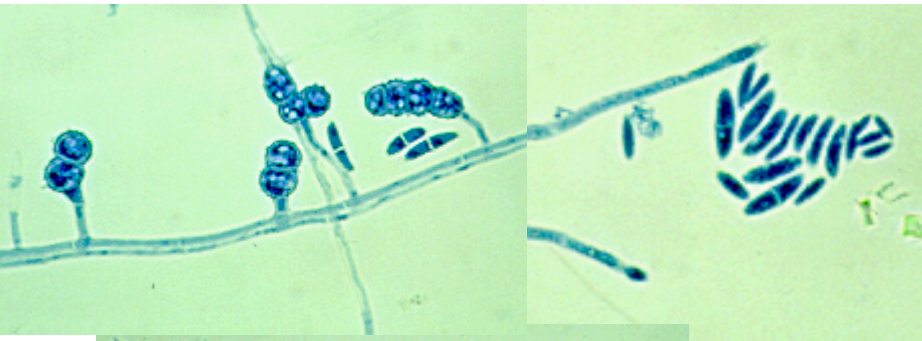


# *Fusarium* (*Gibberella*)– A notorious pathogen

- Can incite diseases in plants, humans and animals
- Many plants at least one *Fusarium*-associated disease (81 of the 101 economically important plants)
- Produce secondary metabolites

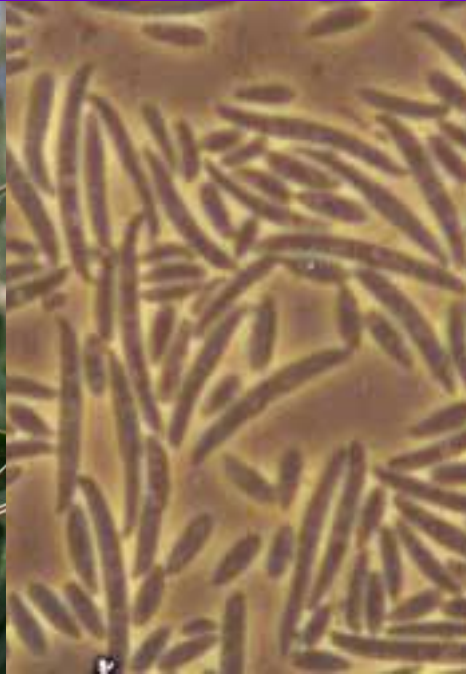


**Ear rot of maize**  
(*Fusarium verticillioides*)



# Bakanae disease of rice (*Fusarium fujikuroi*)

## Fusarium head blight of wheat (*Fusarium graminearum*)



# Crown rot of banana (*Fusarium verticillioides*)



# Fusarium wilt of bottle gourd (*F. oxysporum* f.sp. *lagenariae*)



# Fusarium wilt of bitter melon (*F. oxysporum* fsp. *momordicae*)



## Scab of Wheat and Barley: A Re-emerging Disease of Devastating Impact

**Marcia McMullen**  
North Dakota State University, Fargo

**Roger Jones**  
University of Minnesota, St. Paul

**Dale Gallenberg**  
South Dakota State University, Brookings

**Bakanae disease on the rise:  
A cause for concern  
Gergon, E & Angeles, AT. Poster presented  
at the 37<sup>th</sup> Anniversary & Annual Scientific  
Conference of PMCP. May 2-5,2006. Davao City**

INTERNATIONAL JOURNAL OF PEST MANAGEMENT, 1994, 40(4) 326-336

### Panama disease: return of the first banana menace

(Keywords: banana, electrophoretic karyotype, *Fusarium oxysporum* f. sp. *cubense*, fusarium wilt of banana, *Musa acuminata*, *Musa balbisiana*, Panama disease, plantain, random amplified polymorphic DNA, restriction fragment length polymorphism, vegetative compatibility)

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**Abstract.** Before 1960, Panama disease (fusarium wilt) was the most important disease in the banana export trades. Although the importance of Panama disease decreased after the Cavendish cultivars replaced Gros Michel, recent outbreaks have renewed interest in this problem. Race 4 affects cultivars of the Cavendish subgroup in the subtropics, as well as race 1 and race 2 susceptible. It has caused concern in the tropically based export trades which depend almost entirely on the Cavendish clones. Attention is also drawn to affected non-exported bananas which are important cash crops or staple foods. Although they are not as well documented as those on the Cavendish subgroup, epidemics of the disease on non-exported bananas are far more important.

Revived interest in Panama disease has prompted new research. Breeding programmes have developed dessert and cooking bananas which resist Panama disease, as well as black Sigatoka and the burrowing

export plantations are large monocultures, Panama disease spread rapidly in plantings of the uniformly susceptible host. In addition, since the cause of the disease and its seed-borne dissemination were not clearly understood until about 1920, infected rhizomes were used to establish new plantations long after the disease was recognized (Brandes, 1919; Stover, 1962). The unwitting spread of FOC in seed pieces helped seal the fate of Gros Michel.

Thirty years after the trades converted to the Cavendish cultivars they have been little affected by Panama disease. What, then, are the reasons for this review? One is the appearance of race 4 (Su *et al.*, 1977). Race 4 affects

# POPULATION GENETICS :

## What do we know about it?

### Fisher's Fundamental Theorem of Natural Selection:

- Mean fitness of population always increases
- Rate of increase in fitness is proportional to additive genetic variance for genes that affect fitness



More genetically diverse pathogen populations have greater evolutionary potential

Pathogenic traits affect fitness

# Genetic Structure of Pathogen Populations

The amount and distribution of genetic diversity within and among populations varies

## INCREASE

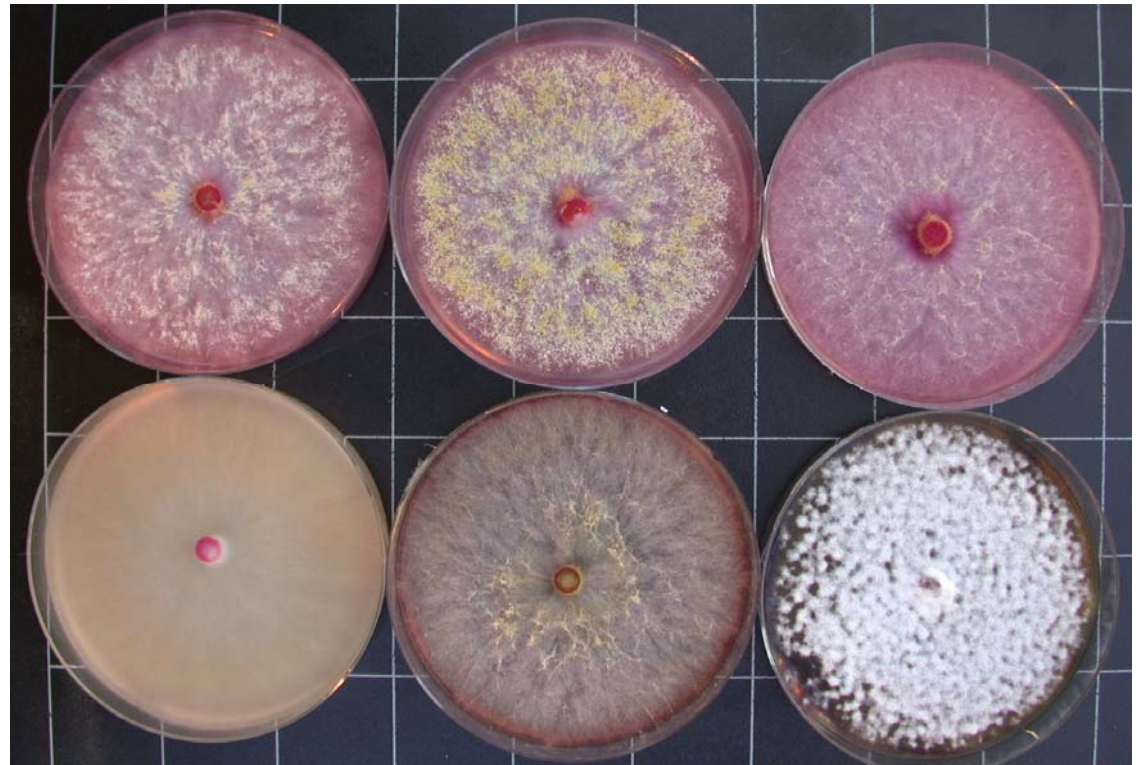
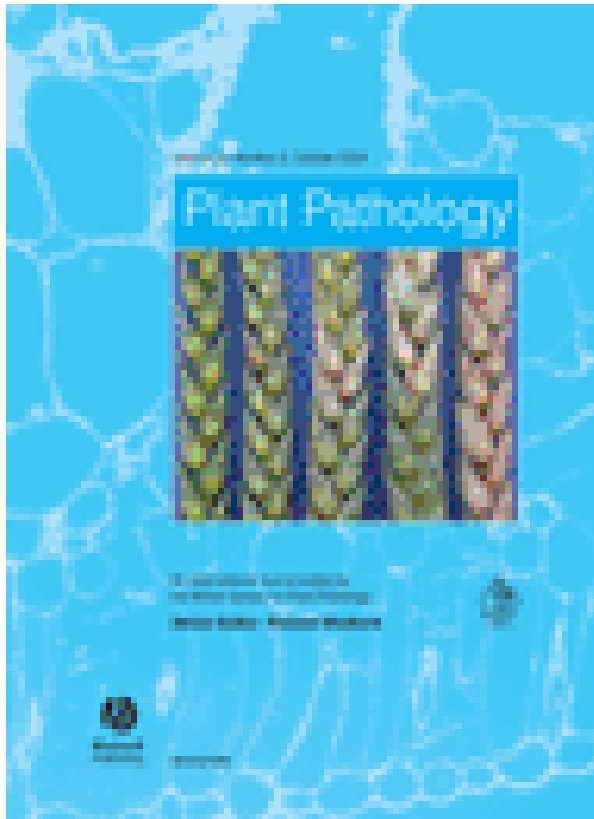
- Recombination
- Gene flow
- Mutation

## DECREASE

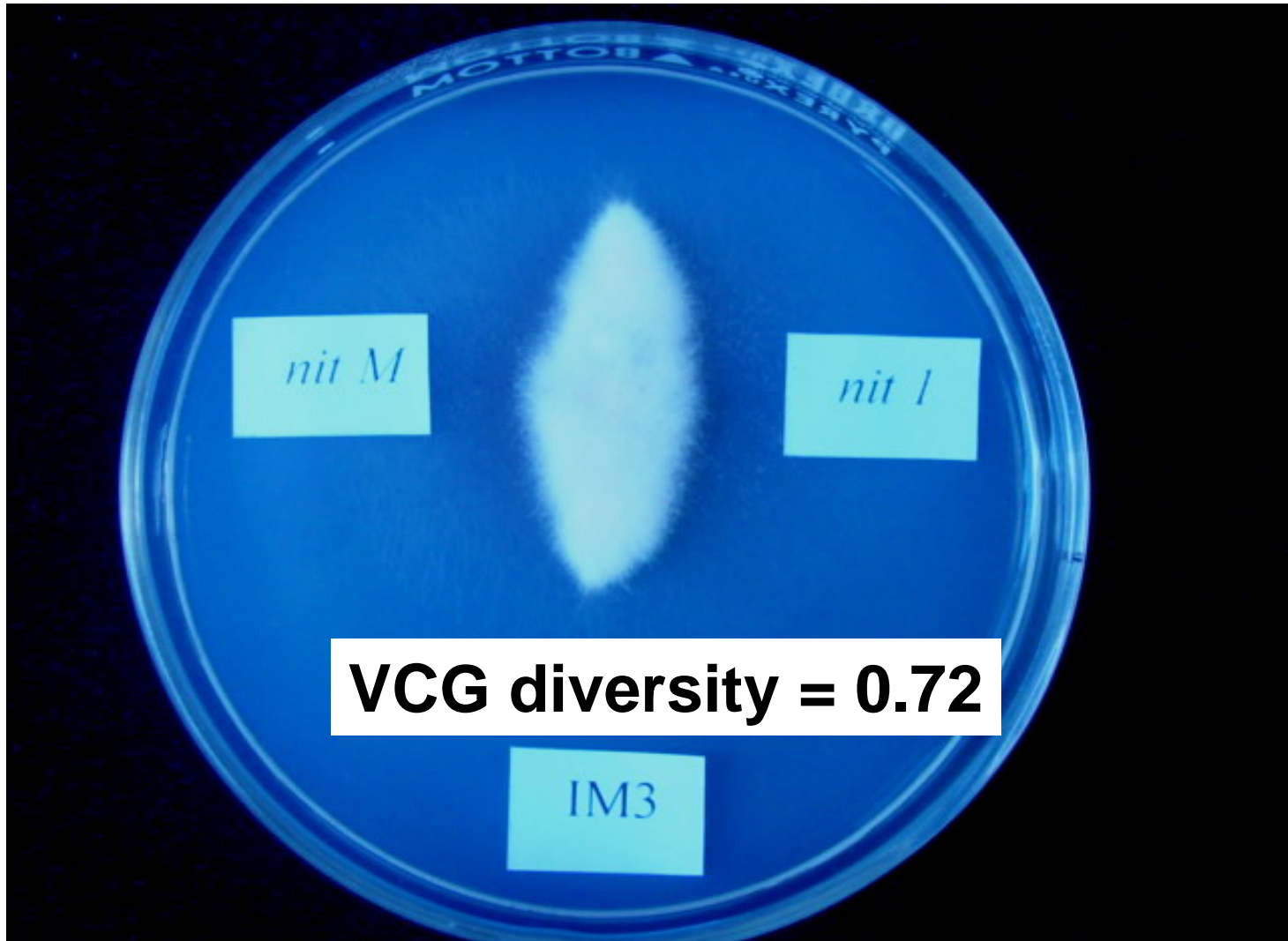
- Selection
- Random drift

Genetic structure is a result of all evolutionary processes that have affected a population (species) through time and space

# Variation of aggressiveness and cultural characters

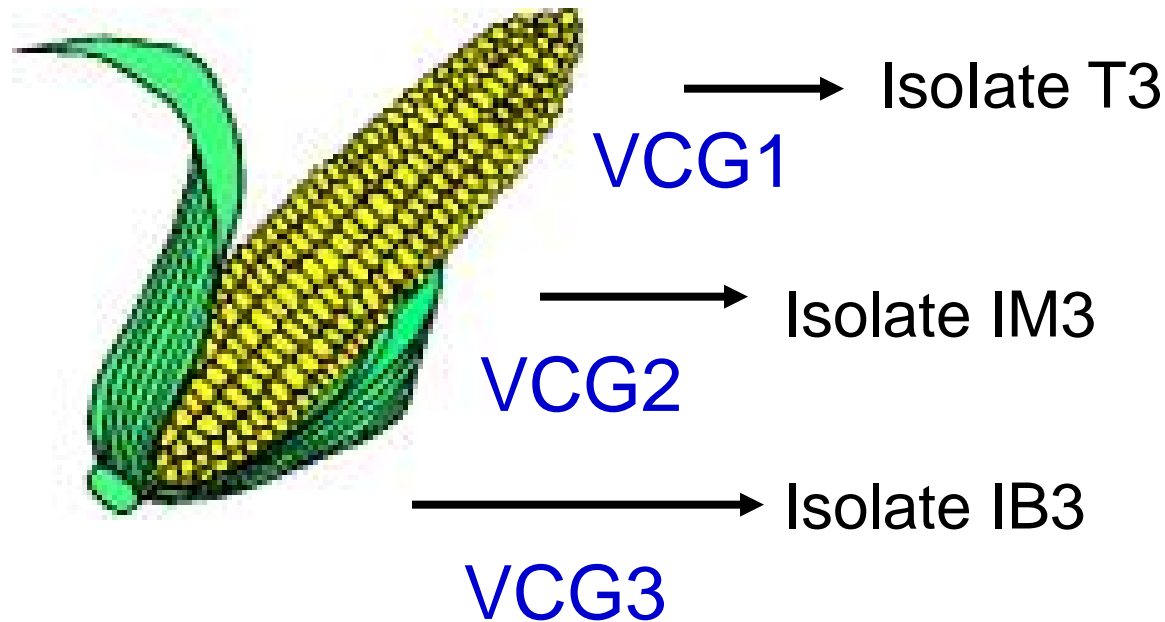


Front cover of Vol 53 of *Plant Pathology* : Cumagun et al. (2004)

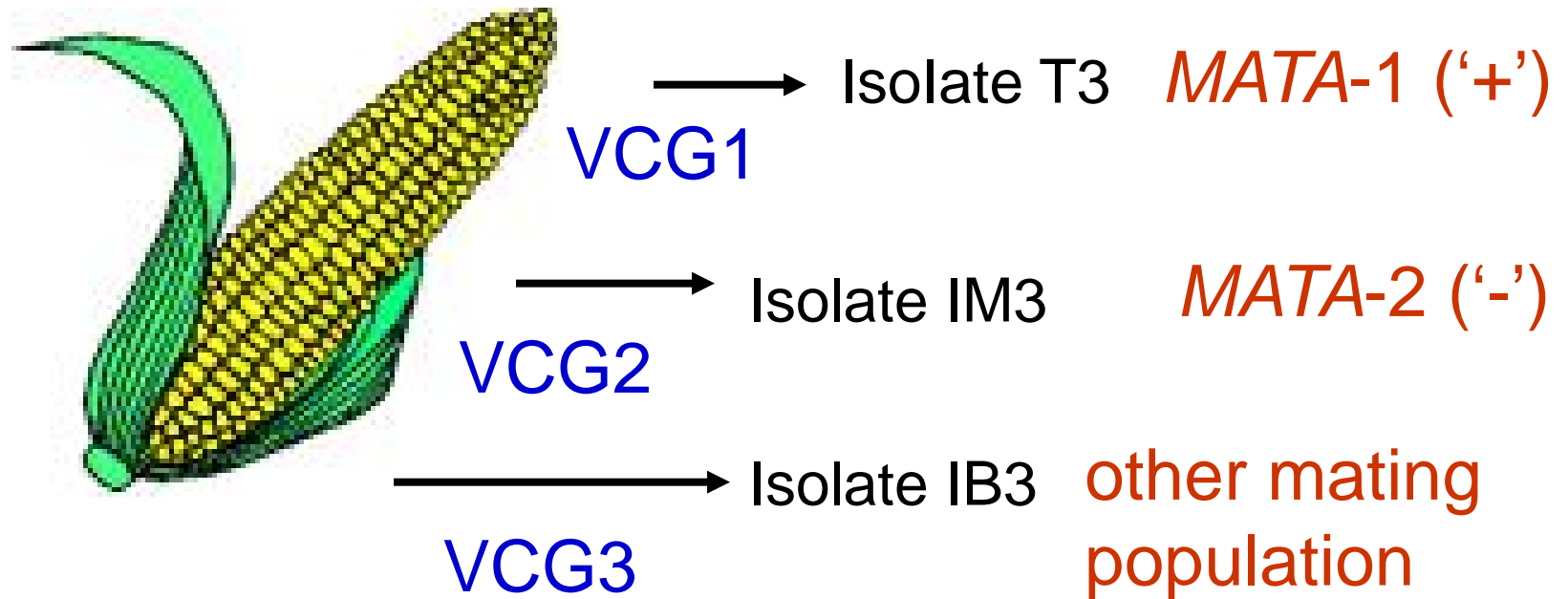


20 isolates grouped into 19 VCGs

# High diversity at small spatial scale



# High diversity at small spatial scale



# Effective population number for *F. verticillioides*

## Effective population number ( $N_e$ )

Mating	$N_{fs}:N_h$	Mating	Male/hermaphrodite	Reference
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## Sexual reproduction of *F. verticillioides* in the Philippines does not occur frequently

27:23	35:15	81	42	Cumagun et al 2008
23:47	62:8	89	26	Chulze et al. 2000
16:23	10:29	97	98	Danielsen et al. 1998
59:17	39:37	69	88	Mansuetus et al. 1997
237:446	342:341	91	89	Leslie and Klein 1996

Source; Cumagun (2008). Journal of Applied Genetics

# Vegetative Compatibility Grouping

2-4 VCGs in *F. oxysporum* in bitter gourd  
2-3 VCGs in *F. oxysporum* in bottle gourd



Medium compatibility



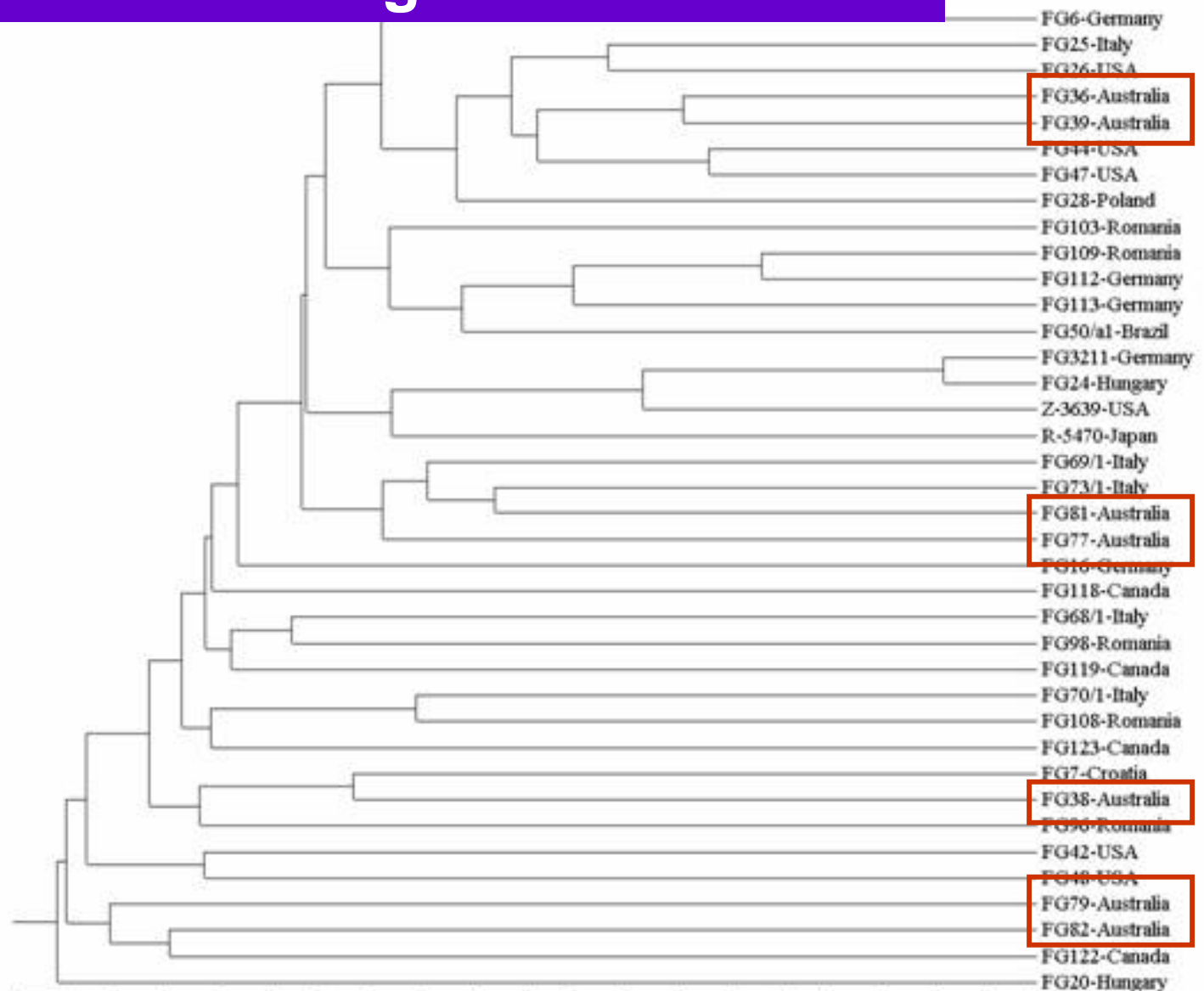
Strong compatibility

Source: Cumagun et al. (2008) Journal of Plant Protection Research

# *F. oxysporum* in Batangas and Bulacan

Host	Batangas	Bulacan
A	<b>No compatibility was detected between upo and ampalaya isolates</b>	
U	<b>Cross infection was observed normally in young plants</b>	
T		
T	<b>No association between pathogenicity and VCG</b>	

# Worldwide Collection: AFLP dendrogram of *F. graminearum* lineage 7

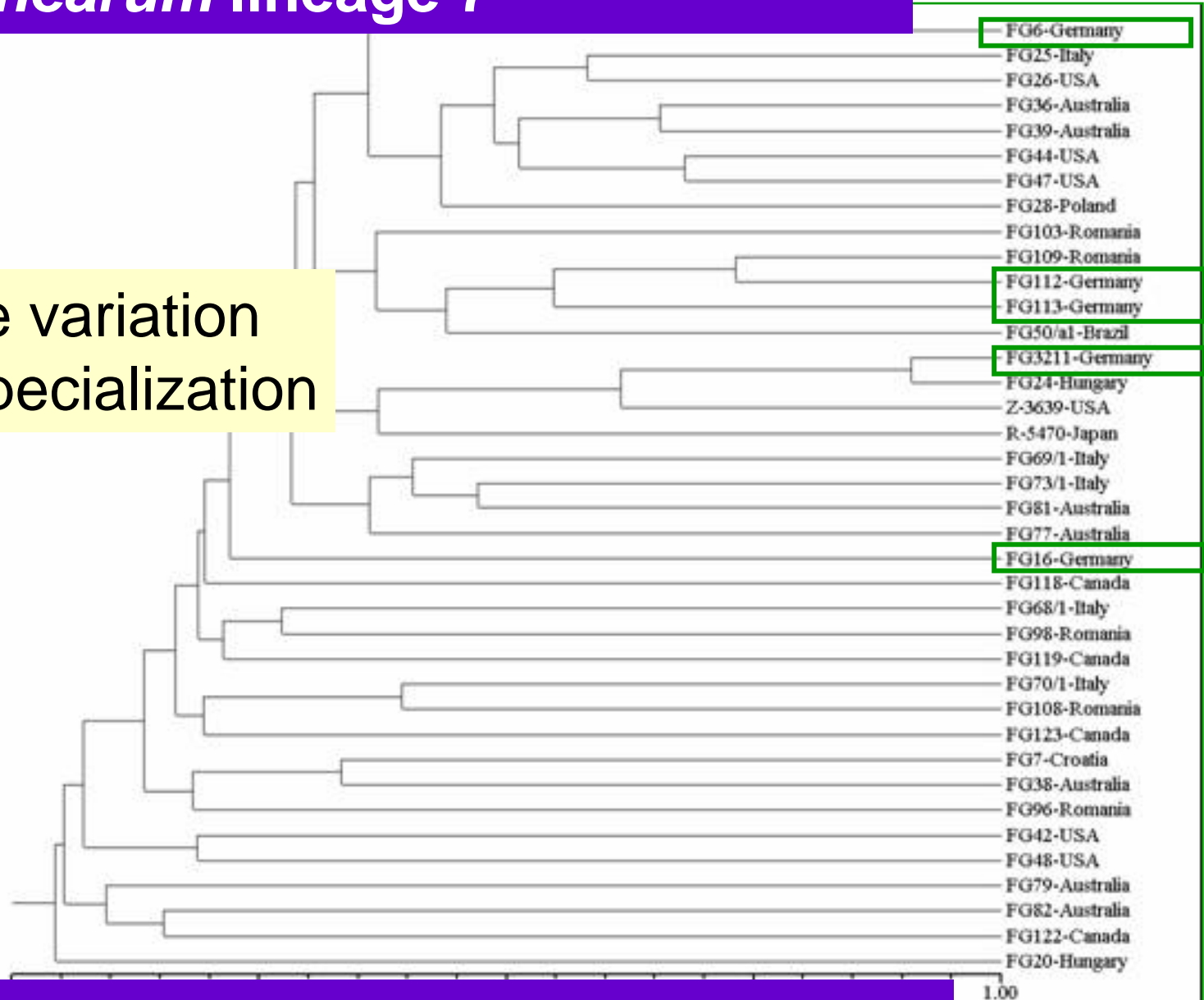


Source: Cumagun et al. 2006. The Philippine Agricultural Scientist

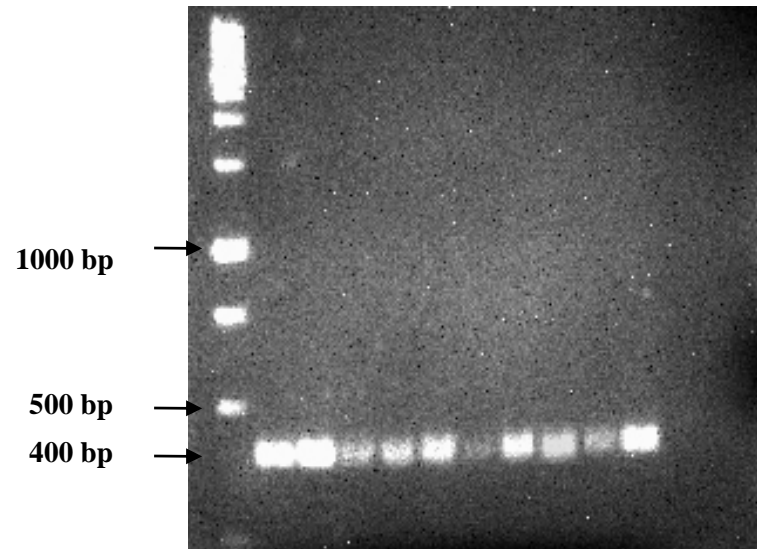
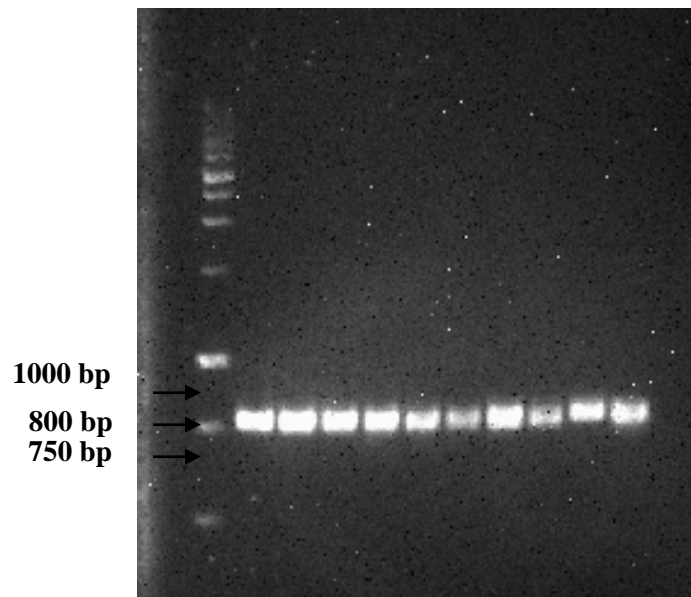
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# Worldwide Collection: AFLP dendrogram of *F. graminearum* lineage 7

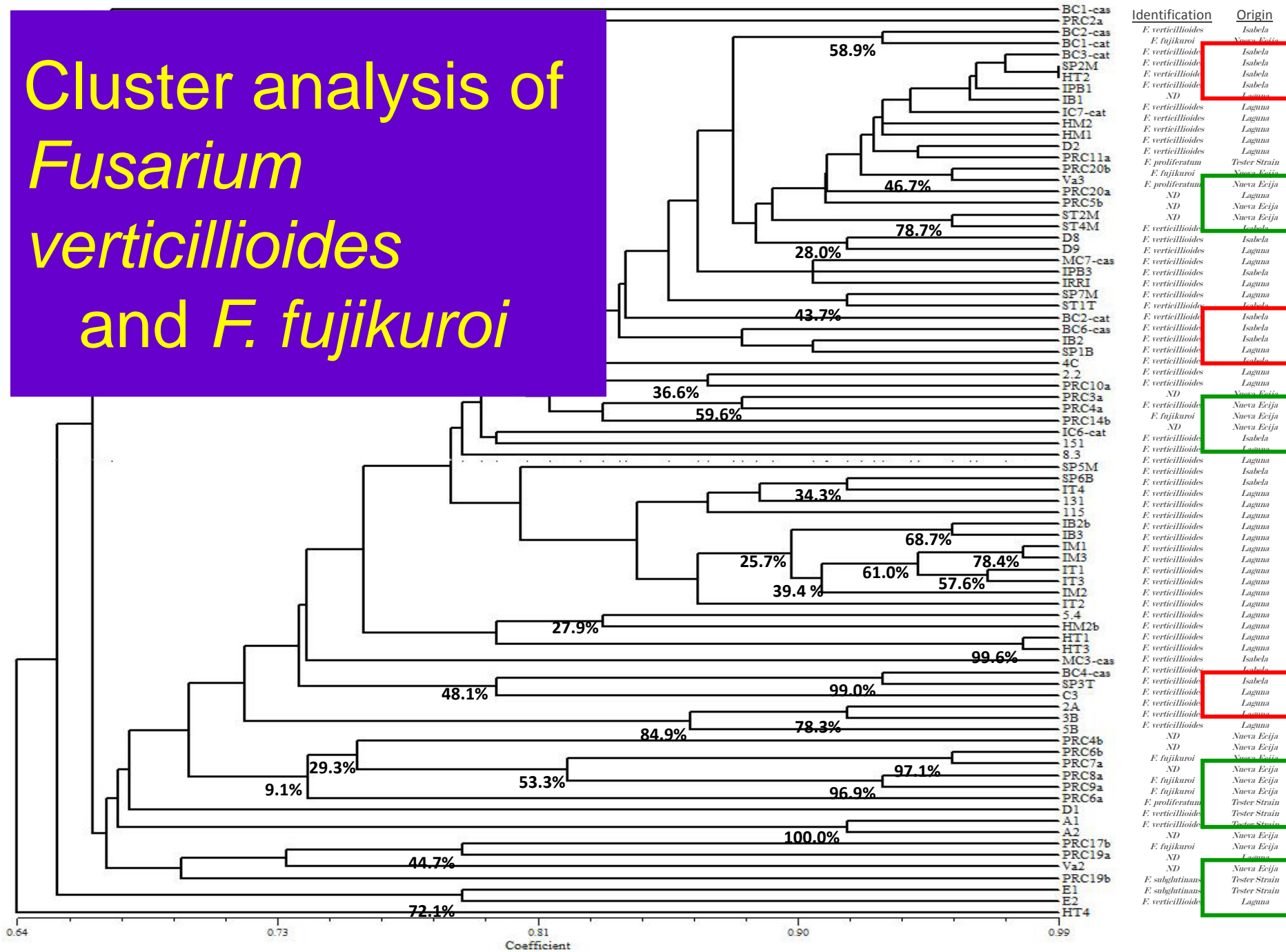
Large variation  
No specialization



# *F. verticillioides* and Fumonisin Detection using PCR Assay

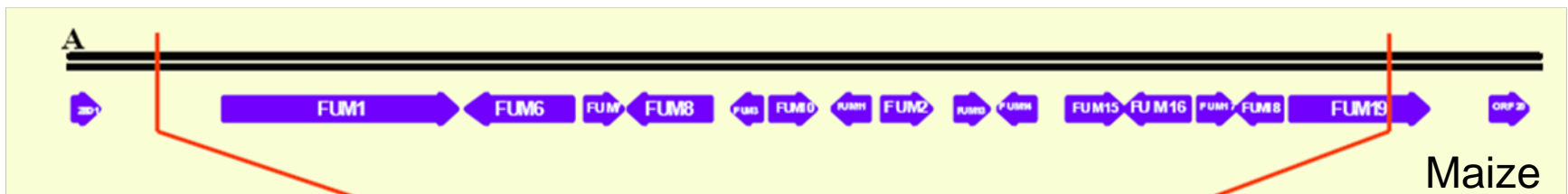


# Cluster analysis of *Fusarium verticillioides* and *F. fujikuroi*



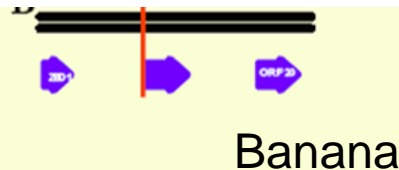
# What is the cause of the non production of fumonisin by *F. verticillioides* strains isolated from banana?

**Excision Hypothesis: 44 kb of the FGC has been excised from banana**



***F. verticillioides* from Philippine banana have the FGC while those in Central America do not have!**

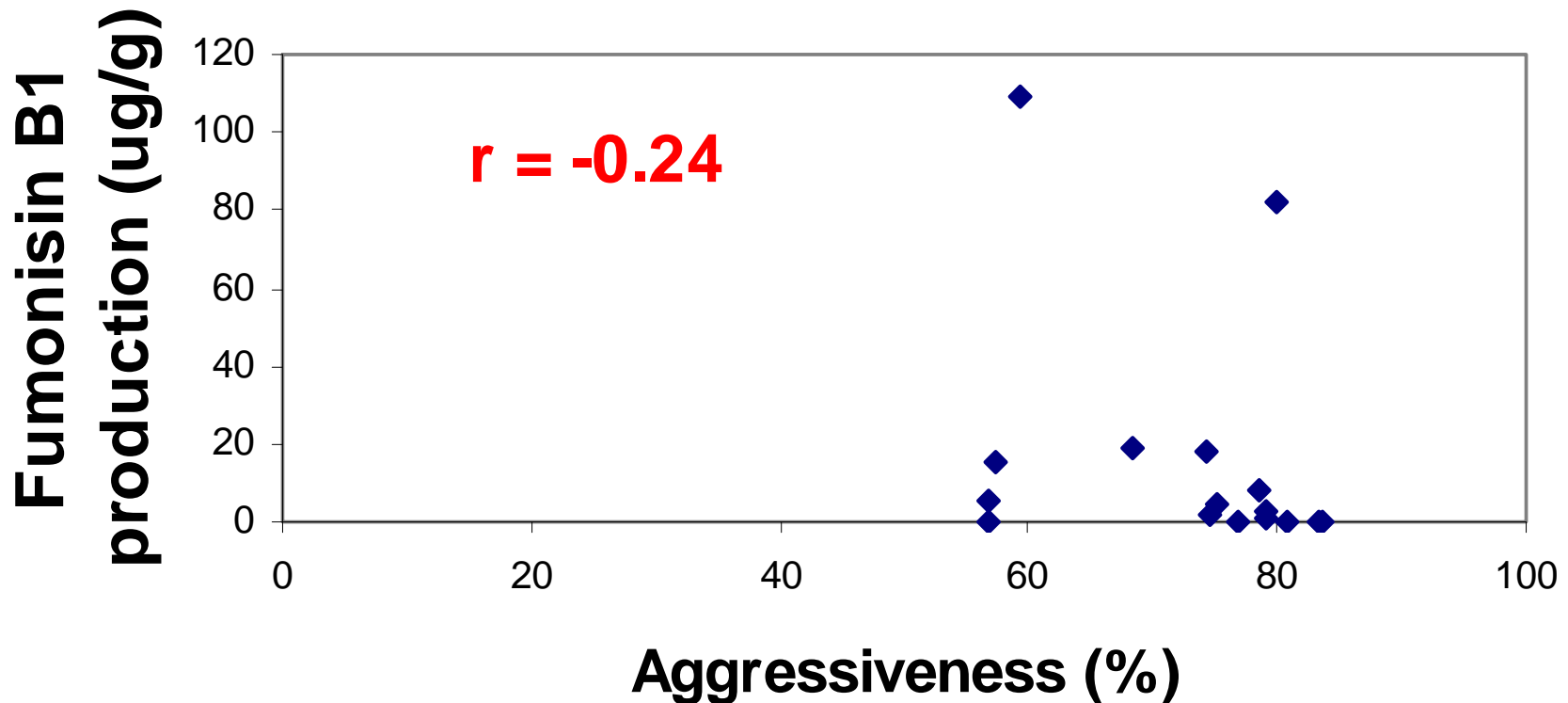
banana. The red line indicates the excision site of a 44 kb sequence corresponding to the main part of the FGC.



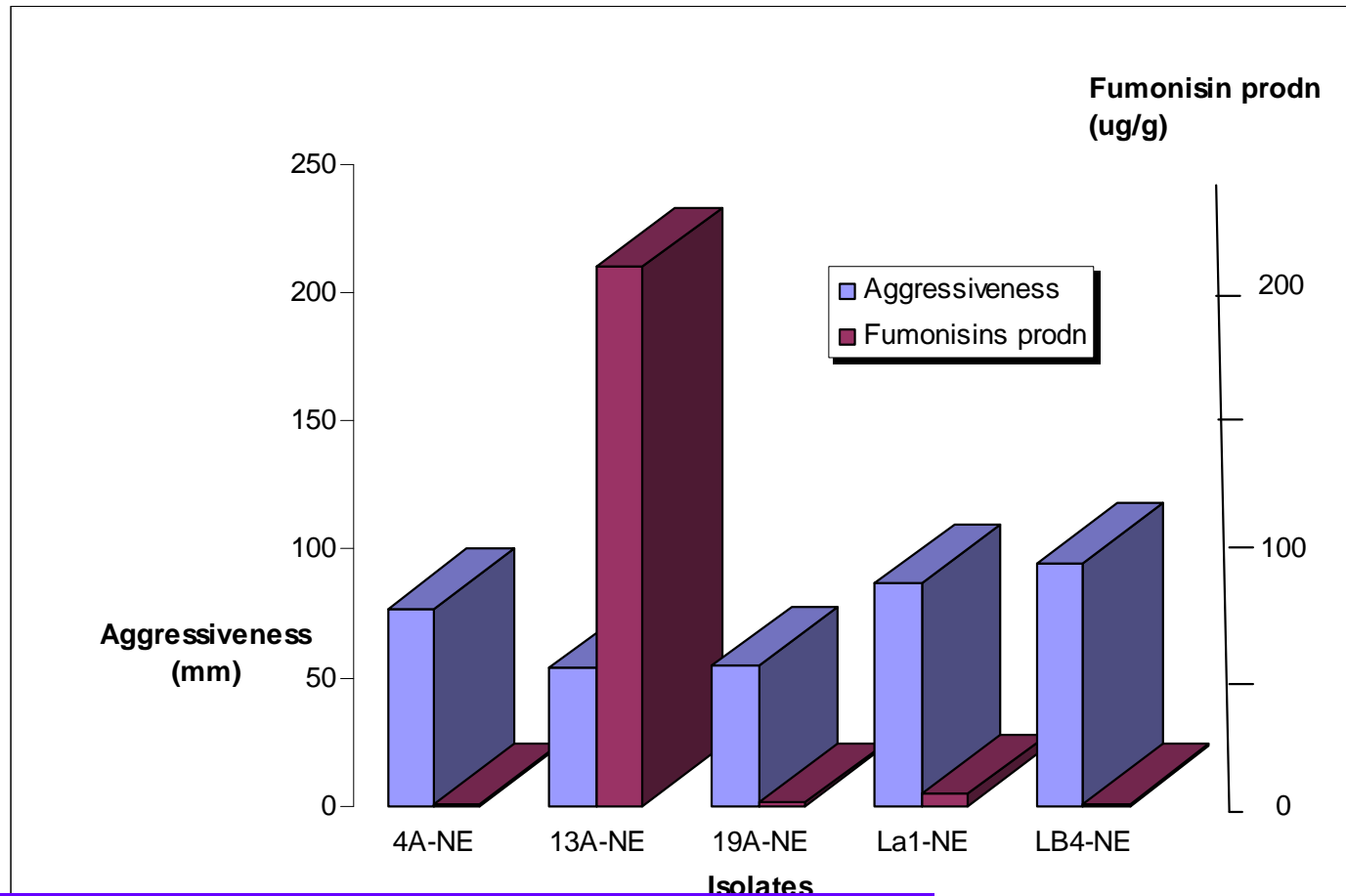
tEF Sequence comparison

Source: Van Hove et al. (2006)

# Low association between aggressiveness and fumonisin production of *F. verticillioides*



# No association between aggressiveness and fumonisin production of *F. fujikuroi*



Source: Cumagun et al. (2008) unpublished results

# Fumonisin production of *F. verticillioides* and *F. fujikuroi* isolates in the Philippines

Source	Host	No of isolates	Mean fumonisin production ( $\mu\text{g/g}$ )		
			FB1	FB2	FB3
Isabela	maize	20	146.75	45.54	9.70
Laguna	maize	16	30.05	10.22	2.12
N. Ecija	rice	7	31.47	5.36	0.52

Source: Cumagun et al. (2007) Asian Conference on Plant Pathology

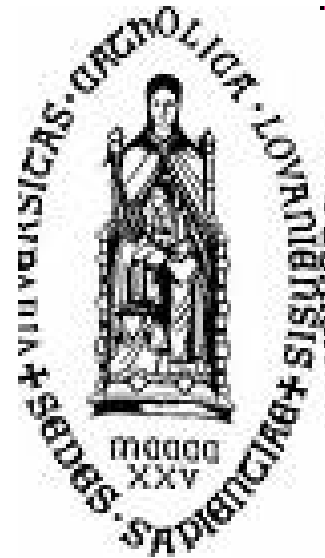
# Genotypic variation among populations of three *Fusarium* species for aggressiveness and mycotoxin production

<i>Fusarium</i> species	Host	No of isolates	Genotypic Range		Reference
			Aggressiveness	Mycotoxin production	
<i>F. verticillioides</i>	maize	20	13.6-25.1cm	0.44-128.45µg/g	Alviar, 2006, Cumagun et al., 2006 Cumagun et al., 2007
<i>F. fujikuroi</i>	rice	43	47.63-125.25 mm	0.86-210.03µg/g	Aguilar, 2007 Cumagun et al., 2007
<i>F. graminearum</i>	wheat	155	5.03-47.75%	4.2-43.7mg/kg	Cumagun and Miedaner 2004
<i>F. oxysporum</i>	ampalaya upo	10	2.92-4.50 1.32-3.63	-	Aguirre, 2007

# Conclusions

- VCG is not correlated with aggressiveness
- Large variation and no specialization for *F. graminearum*, *F. verticillioides* and *F. fujikuroi*.
- High variation in aggressiveness in *F. verticillioides*, *F. fujikuroi* and *F. graminearum*.
- Sexual reproduction in *F. verticillioides* is less frequent.
- *F. verticillioides* from Asia and Africa have the FUM gene cluster while Central America do not.
- Mating population A is prevalent in Philippine corn.
- Philippine *F. fujikuroi* isolates are low fumonsin producers.
- *F. verticillioides* isolates from Northern Luzon are high fumonisin producers compared to Southern Luzon.
- No to low association between aggressiveness and fumonisin production in both rice and maize isolates of *F. verticillioides*

# Acknowledgements



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